Practitioner's Docket No. 100302.16-PCT

CHAPTER II

Preliminary
Classification:

Proposed Class:

Subclass:

TRANSMITTAL LETTER
TO THE UNITED STATES ELECTED OFFICE (EO/US)
(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/US00/22673	17 August 2000 (17.08.00)	None
International Application Number	**International Filing Date**	**International Earliest Priority Date**

TITLE OF INVENTION: INTERACTIVE IRRIGATION SYSTEM
APPLICANT(S): John ADDINK and Tony GIVARGIS

CERTIFICATION UNDER 37 C.F.R. SECTION 1.10*
*(Express Mail label number is **mandatory**.)*
(Express Mail certification is optional.)

I hereby certify that this paper, along with any document referred to, is being deposited with the United States Postal Service on this date January 10, 2001, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL832925450US, addressed to the: US Patent Office, PO Box 2327, Arlington, VA 22202.

Kristin J. Azcona

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Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under
35 U.S.C. Section 371:

a. This express request to immediately begin national examination procedures (35 U.S.C. Section 371(f)).

b. The U.S. National Fee (35 U.S.C. Section 371(c)(1)) and other fees (37 C.F.R. Section 1.492) as indicated below:

2. Fees

CLAIMS FEE*	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALC-ULATIONS
	TOTAL CLAIMS	24 -20 =	4	x $18.00 =	$72.00
	INDEPEN-DENT CLAIMS	3 - 3 =	0	x $42.00 =	$0.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $140.00				$0.00
BASIC FEE	U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in Section 1.482 has been paid on the international application to the U.S. PTO: and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 C.F.R. Section 1.492(a)(4)) $50.00				$50.00
	Total of above Calculations				= $122.00
SMALL ENTITY	Reduction by 1/2 for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR Sections 1.9, 1.27, 1.28)				- $61.00
	Subtotal				$61.00
	Total National Fee				$61.00
	Fee for recording the enclosed assignment document $40.00 (37 C.F.R. Section 1.21(h)). See attached "ASSIGNMENT COVER SHEET".				$0.00
TOTAL	Total Fees enclosed				$61.00

*See attached Preliminary Amendment Reducing the Number of Claims.

A check in the amount of $61.00 to cover the above fees is enclosed.

3. A copy of the International application as filed (35 U.S.C. Section 371(c)(2)) is not required, as the application was filed with the United States Receiving Office.

4. A translation of the International application into the English language (35 U.S.C. Section 371(c)(2)) is not required as the application was filed in English.

5. Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. Section 371(c)(3)) are transmitted herewith.

6. A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. Section 371(c)(3)) is not required as the amendments were made in the English language.

7. A copy of the international examination report (PCT/IPEA/409) is not required as the application was filed with the United States Receiving Office.

8. Annex(es) to the international preliminary examination report is/are not required as the application was filed with the United Stated Receiving Office.

9. A translation of the annexes to the international preliminary examination report is not required as the annexes are in the English language.

10. An oath or declaration of the inventor (35 U.S.C. Section 371(c)(4)) complying with 35 U.S.C. Section 115 is submitted herewith, and such oath or declaration identifies the application and any amendments under PCT Article 19 that were transmitted as stated in Section 3 and/or 5; and states that they were reviewed by the inventor as required by 37 C.F.R. Section 1.70.

II. Other document(s) or information included:

11. An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a) is not required, as the application was searched by the United States International Searching Authority.

12. An Information Disclosure Statement under 37 C.F.R. Sections 1.97 and 1.98 will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. Section 371(c).

13. Additional documents:

a. Copy of request (PCT/RO/101)

14. The above items are being transmitted before 30 months from any claimed priority date.

AUTHORIZATION TO CHARGE ADDITIONAL FEES

The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No.: 500341

37 C.F.R. Section 1.492(a)(1), (2), (3), and (4) (filing fees)

37 C.F.R. Section 1.492(b), (c), and (d) (presentation of extra claims)

37 C.F.R. Section 1.17 (application processing fees)

37 C.F.R. Section 1.17(a)(1)-(5) (extension fees pursuant to Section 1.136(a))

37 C.F.R. Section 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 20 months after the priority date).

Date: January 10, 2002

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Practitioner's Docket No. **302.16-PCT**

IN THE INTERNATIONAL BUREAU (WIPO)

International Application Number	International Filing Date	International Earliest Priority Date
PCT/US00/22673	17 August 2000	None

Title of Invention: **Interactive Irrigation System**
Applicant: **Aqua Conservation Systems, Inc.**

International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20
Switzerland

LETTER FOR PCT ARTICLE 19
(PCT SECTION 205)

1. Applicant herewith submits replacement sheets(s) number(ed) **11-14** to replace sheet(s) number(ed) **11-14** originally filed for this application.

2. In respect of each claim appearing in the international application based on the replacement sheets submitted herewith, and in accordance with PCT Section 205, the following claim(s) is/are:

(i)	unchanged:	claim(s) **2-5, 7-9, 11-24**
(ii)	cancelled:	claim(s) **0**
(iii)	new:	claim(s) **0**
(iv)	replacement of one or more claims as filed, as follows: **1, 6, and 10**	
(v)	the result of the division of one or more claims as filed, as follows: **0**	

Dear Sir:

The Search Report dated 08 August 2001 designated three references as being relevant to patentability. In response, claims 1, 6, and 10 have been amended. The amended claim and the references are addressed below seriatim.

1. (Amended) An irrigation system comprising:

each of an irrigation controller and a water application device physically situated at a location of a user [user's location], the controller at least partially controlling the water application device;

a distal computer remote from the user location;

a first communication system that exchanges information between the irrigation controller and the distal computer;

a second communication system that exchanges information between the irrigation controller and the user;

a third communication system that exchanges information between the user and the distal computer; [and]

a fourth communication system that exchanges information between the distal computer and a third party[.] ; and

wherein each of the first communication system, the third communication system, and the fourth communication system comprise a public, packet switched network.

6. (Amended) The irrigation system of claim 1, wherein the second communication system [at least one of the first, third, and fourth communication systems] comprises a public, packet switched network.

10. (Amended) A method of operating an irrigation system comprising:

physically situating each of an irrigation controller and a water application device at a location of a user [user's location];

utilizing the controller to at least partially control the water application device;

providing a first communication system comprising a public, packet switched network;

coupling the irrigation controller and a distal computer using [a] the first communication system;

coupling the irrigation controller and the user using a second communication system;

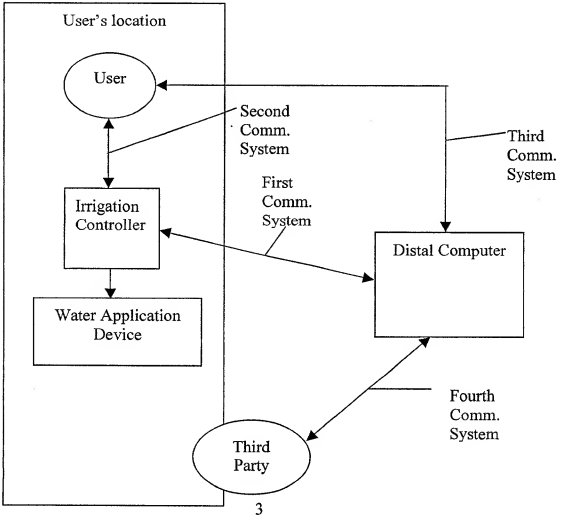
the user entering landscape irrigation operating information into the irrigation controller using the second communication system; and

the irrigation controller causing at least a portion of the landscape irrigation operating information to be transmitted to the distal computer using the first communication system.

Overview of the claims

Amended claim 1 recites a user, an irrigation controller, and a water application device all physically situated at the user's location. The irrigation controller, the user, a distal computer, and a third party exchange information over a plurality of communication systems, many of which comprise a public, packet switched network such as the Internet. Support for amending claim 1 to include a public, packet switched network is disclosed in the Summary of the Invention section of the specification, among other places. Amended claim 10 discloses an irrigation controller, a user, and a distal computer that are coupled to each other using a plurality of communication systems that include a public packet switched network such as the Internet. The irrigation controller causes at least a portion of the landscape operating information to be transmitted to the distal computer over the public, packet switched network.

Diagram of amended claim 1

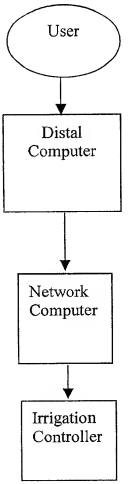


Townsend (U.S. Patent 6076740)

Overview of Townsend

Townsend teaches an irrigation control system that utilizes a main computer to measure weather conditions in a first area, and to measure rainfall in a sub-area of the first area. Townsend is directed toward control of irrigation over a large area ("The area in which the irrigation is to be controlled is defined. In most cases this will be the greater metropolitan area and environs of a large city..." (Column 4, lines 3-5)). Townsend teaches that communication is linear and travels from an external user to a network computer to a main computer to an irrigation controller (Figure 1).

Diagram of Townsend



Claim 1

The Office considers claims 1-7 to be anticipated by Townsend. The applicant respectfully disagrees with that position, especially in view of the amendments contained herein.

"Anticipation under 35 USC § 102 requires the disclosure in a single piece of prior art of each and every limitation of a claimed invention..." *Rockwell International Corp. v. United States,* 147 F.3d 1358, 1363, 47 USPQ2d 1027, 1031 (Fed. Cir. 1998), (emphasis added).

Amended claim 1 (and claims 2-9 by virtue of their dependence on claim 1) recites the following limitations that Townsend fails to disclose:

- a user physically situated at the user's location;

- a third party;
- a plurality of communication systems ("a first communication system", "a second communication system", "a third communication system", and "a fourth communication system");and
- "each of the first communication system, the third communication system, and the fourth communication system comprise a public packet switched network"

Distal is defined in the specification as "more than 1 km away" (page 5, line 3). "Third party" is defined as "a legal person other than the user" (page 5, line 4).

Townsend fails to disclose "a user physically situated at the user's location". As Townsend teaches a system directed toward control of irrigation over a large area ("The area in which the irrigation is to be controlled is defined. In most cases this will be the greater metropolitan area and environs of a large city..." (Column 4, lines 3-5)), it is not likely that the user (the one who controls the irrigation system) is physically situated at the same location as the controller.

Townsend also fails to disclose both a "third party" as defined by the specification, and four communication systems. Additionally, Townsend does not teach a communication system that comprises a public packet switched network. Since Townsend does not disclose all of the limitations of amended claim1, it does not anticipate amended claim 1 (and claims 2-9 by virtue of their dependence on amended claim 1).

With regard to obviousness of claims that are dependent upon claim 1, the Office considers claims 8, 9 to be obvious over Townsend. The applicant respectfully disagrees with that position, especially in view of the amendments contained herein. Since claims 8 and 9 are dependent upon amended claim 1, if amended claim 1 is non-obvious, then claims 8 and 9 are also non-obvious. Thus, the following argument is directed at the non-obviousness of claim 1. Claim 1 recites:

> "a first communication system that exchanges information between the irrigation controller and the distal computer;

a second communication system that exchanges information between the irrigation controller and the user;

a third communication system that exchanges information between the user and the distal computer;

a fourth communication system that exchanges information between the distal computer and a third party; and

wherein each of the first communication system, the third communication system, and the fourth communication system comprise a public packet switched network."

First, Townsend does not teach or suggest a third party at all, and the reference lacks the motivation to include a third party since there is no apparent desirability of having a third party. Second, there is no teaching or suggestion to exchange information using a first communication system, a second communication system, a third communication system, and a fourth communication system as amended claim 1 requires. Additionally, there is only one communication system taught by Townsend, however there are four communication systems in the claimed subject matter (see diagrams above). Thus, communication between the distal computer and the irrigation controller, for example, does not pass through any of the other components while communication between the irrigation controller and the distal computer in Townsend must pass through the main computer.

Claim 10

The Office considers claims 10-15, 19, and 20 to be anticipated by Townsend. The applicant respectfully disagrees with that position, especially in view of the amendments contained herein.

Similar to amended claim 1 above, amended claim 10 recites "physically situating...an irrigation controller ...at a location of a user", and using a first, and second communication system wherein the first communication system comprises a public packet switched network. Additionally, claim 10 provides "a first communication system comprising a public packet switched network", and requires that the irrigation controller cause "at least a portion of the landscape information (entered by the user) to be transmitted to the distal computer".

Townsend fails to disclose these limitations, and therefore does not anticipate claim 10 or any of the claims that are dependent upon claim 10.

Regarding non-obviousness of claim 10, Townsend lacks any teaching or suggestion to include more than one communication system, especially one that comprises a public packet switched network such as the Internet.

Miller (U.S. Patent 5479399) and Hirsch (U.S. Patent 4396149)

The Office considers claim 8, 9, 16, 17, 21-24 to be obvious over Miller and claim 18 to be obvious over Hirsch. Since all of these claims are dependent upon either claim 1 or claim 10, the need to argue these claims is obviated subject to the allowance of claims 1 and 10.

Respectfully submitted,

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CLAIMS

What is claimed is:

1. An irrigation system comprising:

each of an irrigation controller and a water application device physically situated at a location of a user, the controller at least partially controlling the water application device;

a distal computer remote from the user location;

a first communication system that exchanges information between the irrigation controller and the distal computer;

a second communication system that exchanges information between the irrigation controller and the user;

a third communication system that exchanges information between the user and the distal computer;

a fourth communication system that exchanges information between the distal computer and a third party; and

wherein each of the first communication system, the third communication system, and the fourth communication system comprise a public packet switched network.

2. The irrigation system of claim 1, wherein the exchange of information between each of the irrigation controller and the distal computer, the irrigation controller and the user, the user and the distal computer; and the distal computer and a third party, are bi-directional.

3. The irrigation system of claim 1, further comprising a microprocessor disposed in the irrigation controller, that facilitates the exchange of information between the irrigation controller and the distal computer.

4. The irrigation system of claim 1, further comprising a microprocessor disposed in a second unit separate from the irrigation controller, that facilitates the exchange of information between the irrigation controller and the distal computer.

5. The irrigation system of claim 1, further comprising a storage device that stores data at the user location.

6. The irrigation system of claim 1, wherein the second communication system comprises a public, packet switched network.

7. The irrigation system of claim 1 wherein the first communication system comprises a two-way pager.

8. The irrigation system of claim 1 wherein the first communication system comprises a web page interface.

9. The irrigation system of claim 1, wherein the second communication system comprises a dedicated link between the controller and a personal computer.

10. A method of operating an irrigation system comprising:
physically situating each of an irrigation controller and a water application device at a location of a user;
utilizing the controller to at least partially control the water application device;
providing a first communication system comprising a public packet switched network;
coupling the irrigation controller and a distal computer using the first communication system;
coupling the irrigation controller and the user using a second communication system;
the user entering landscape irrigation operating information into the irrigation controller using the second communication system; and
the irrigation controller causing at least a portion of the landscape irrigation operating information to be transmitted to the distal computer using the first communication system.

11. The method of claim 10 wherein the step of entering the landscape irrigation operating information comprises the user entering the landscape irrigation operating information into a personal computer, and the personal computer transmitting the information to the irrigation controller via the second communication system.

12. The method of claim 10, further comprising:

6. The irrigation system of claim 1, wherein the second communication system comprises a public, packet switched network.

7. The irrigation system of claim 1 wherein the first communication system comprises a two-way pager.

8. The irrigation system of claim 1 wherein the first communication system comprises a web page interface.

9. The irrigation system of claim 1, wherein the second communication system comprises a dedicated link between the controller and a personal computer.

10. A method of operating an irrigation system comprising:

physically situating each of an irrigation controller and a water application device at a location of a user;

utilizing the controller to at least partially control the water application device;

providing a first communication system comprising a public packet switched network;

coupling the irrigation controller and a distal computer using the first communication system;

coupling the irrigation controller and the user using a second communication system;

the user entering landscape irrigation operating information into the irrigation controller using the second communication system; and

the irrigation controller causing at least a portion of the landscape irrigation operating information to be transmitted to the distal computer using the first communication system.

11. The method of claim 10 wherein the step of entering the landscape irrigation operating information comprises the user entering the landscape irrigation operating information into a personal computer, and the personal computer transmitting the information to the irrigation controller via the second communication system.

12. The method of claim 10, further comprising:

providing the controller with a microprocessor programmed to receive additional information from the distal computer via the first communication system; and

the microprocessor determining an irrigation schedule based at least in part on the landscape irrigation operating information from the user, and the additional information from the distal computer.

13. The method of claim 12, further comprising:
providing the controller with local water usage data; and
the microprocessor determining an irrigation schedule based at least in part on the water usage data.

14. The method of claim 13 wherein the step of determining an irrigation schedule further includes the microprocessor computing a desired quantity of water to be applied to a landscape at the user's location for a specific period of time.

15. The method of claim 14 wherein the period of time is at least one day.

16. The method of claim 13 wherein the additional information from the distal computer includes weather data, and further comprising the microprocessor computing an ETo value.

17. The method of claim 16 further comprising the microprocessor comparing the ETo value to the desired quantity of water applied to the landscape.

18. The method of claim 13, wherein the water usage data includes water pressure data.

19. The method of claim 13, further comprising coupling the user and the distal computer using a third communication system;

20. The method of claim 13, further comprising coupling the distal computer and a third party using a fourth communication system.

21. The method of claim 13 further comprising the microprocessor sending a warning to the user via the second communication system when an aspect of the irrigation system falls outside of a predetermined parameter.

22. The method of claim 13 further comprising the microprocessor preventing an operation of the irrigation system when the irrigation system falls outside of the predetermined parameters.

23. The method of claim 13 wherein the information transmitted to the distal computer comprises a calculated estimate of water actually applied at a station for a time period.

24. The method of claim 23 wherein the information transmitted to the distal computer further includes a relationship between the calculated estimate of water actually applied at a station for a time period, and a computed ETo for the station for the time period.

INTERACTIVE IRRIGATION SYSTEM

Field of the Invention

The field of the invention is irrigation systems.

Background of the Invention

In arid areas of the world water is becoming one of the most precious natural resources. Meeting future water needs in these arid areas may require aggressive conservation measures. This in turn requires irrigation systems that apply water to the landscape based on the water requirements of the plants. Many irrigation controllers have been developed for automatically controlling application of water to landscapes. Known irrigation controllers range from simple devices that control watering times based upon fixed schedules, to sophisticated devices that vary the watering schedules according to local geography and climatic conditions.

With respect to the simpler types of irrigation controllers, a homeowner typically sets a watering schedule that involves specific run times and days for each of a plurality of stations, and the controller executes the same schedule regardless of the season or weather conditions. From time to time the homeowner may manually adjust the watering schedule, but such adjustments are usually only made a few times during the year, and are based upon the homeowner's perceptions rather than the actual watering needs. One change is often made in the late spring when a portion of the yard becomes brown due to a lack of water. Another change is often made in the late fall when the homeowner assumes that the vegetation does not require as much watering. These changes to the watering schedule are typically insufficient to achieve efficient watering.

More sophisticated irrigation controllers usually include some mechanism for automatically making adjustments to the irrigation run times to account for daily environmental variations. However, due to the complexity of these irrigation controllers, the homeowner, after the irrigation controller is initially installed, makes few if any changes to the irrigation controller settings and may not even check if the irrigation controller is operating properly unless the landscape plant material begins browning and/or dying.

Additionally, since these irrigation controllers automatically operate the irrigation system the homeowner makes no preparation for someone to check the system when they are absent

from their residence for an extended period of time, such as on a vacation. The irrigation controller is just a machine and for any number of reasons the irrigation controller may not continue to operate correctly, such as if the electricity to the residence is temporarily turned off.

Because of user disinterest and/or lack of knowledge in the operation of present automatic irrigation systems, there exists a need for a cost-effective method to assist the irrigation user in the attaining of more efficient irrigation of the landscape and in the regular monitoring of the operation of the irrigation system.

There are irrigation systems that are entirely or partly controlled by a distal computer that is located at a remote site from the irrigation controller. One such system disclosed in US Patent No. 5,208,855, issued May 1993, to Marian, broadcasts potential evapotranspiration (ETo) values for multiple geographic zones. Irrigation controllers receive and extract appropriate data for the local conditions, and then use the extracted data to calculate run times. However, there is no regular monitoring, other than by the user, of whether the irrigation controllers actually utilized and modified the irrigation schedule based on the broadcast ETo values. Another irrigation system disclosed in US Patent No. 5,696,671, issued December 1997, and US Patent No. 5,870,302, issued February 1999, both to Oliver, uses a central computer to compute a watering factor that is sent to the irrigation site to modify the watering schedule at the site. The watering factor is partially based on information the central computer receives from the irrigation site. As with the above patent, so also with this patent, there is no monitoring of whether the irrigation controller is applying the information transmitted from the central computer in the irrigating of the landscape.

A large irrigation system disclosed in US Patent No. 5,479,339 issued December 1995 to Miller, has management personnel located remote from the irrigation site and operators located at the irrigation site. Information is transmitted from the irrigation site to management personnel so they can monitor the quantity of water that is applied at the irrigation site. Irrigation systems such as these are either to large or their cost would prohibit their use on residential sites and smaller commercial landscape sites.

In addition to the above listed problems with existing known irrigation systems, there are also no known irrigation systems that communicate with the user on how efficient their irrigation system is operating and/or provide them with information on how they can improve the efficiency in the operation of their irrigation systems.

Current computer technology allows information to be electronically transmitted between two computers. Also, computers at remote locations are being used to control some types of devices. One such system disclosed in US Patent No. 6,053,844, issued April 2000, to Clem uses a computer at a remote site to directly control a fitness device via an Internet system. The user of the fitness device can also interact on-line with a fitness expert to engage in real time two way communications.

The present invention uses a distal computer at a remote site to assist the irrigation user in attaining more efficient irrigation of the landscape and the distal computer, at the remote site, monitors the operation of the irrigation system. In a preferred embodiment of the present invention the distal computer, at the remote site, communicates with an irrigation controller at the user's site, with the user, and with a third party via the Internet system.

Summary of the Invention

In various aspects of the invention, an irrigation system exchanges information between an irrigation controller and a distal computer, between the irrigation controller and a user, between the user and the distal computer, and between the distal computer and a third party.

In preferred embodiments at least one of the first, second, third, and fourth communication systems may comprise a public, packet switched network such as the Internet. More preferably more than one, or even all of the one of the first, second, third, and fourth communication systems comprises such a network. In still other embodiments, the second communication system may advantageously comprise a direct, hard-wired link. Exchange of information may be bi-directional.

In especially preferred embodiments a microprocessor is disposed in the irrigation controller at the user location, and is programmed for transmitting information, receiving information, and controlling operation of the irrigation controller.

The information transmitted among two or more of the user, controller, distal computer, and third party may advantageously include water usage data, weather data, actual water ETo data, and so forth. ETo may be provided to the controller, or calculated or estimated by the controller.

The microprocessor in the controller may advantageously be programmed to detect problems with the irrigation. This is preferably accomplished by setting one or more parameters within which the irrigation system should operate. If the operation of the irrigation system falls outside of the parameters, a warning may be sounded to the user, distal computer, or third party. Severe problems may result in shut down of one or more aspects of the irrigation system.

In yet another aspect of preferred systems, the user may be able to obtain information regarding the irrigation system from the distal computer. Such Information may include operating parameters such as irrigation run times, irrigation water flow data, irrigation water pressure data, and computed parameters such as computed ETo, total water applied to the landscape during a specified time period, percent of ETo actually applied, and educational information on water conservation. Similar information may be made available to a water district or other third party.

Various objects, features, aspects, and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief Description of the Drawings

Figure 1 is a list of four communication systems

Figure 2 is a schematic representation of an interactive irrigation system according to the present invention.

Figure 3 is a schematic of an irrigation controller.

Detailed Description

As used herein, an "irrigation controller" is a physical device that controls operation of one or more water application devices according to a schedule, and is situated locally (i.e., within 1 kilometer (km) of any of the water application devices being controlled). The term "user" is taken to mean a natural person who has at least some interaction with the irrigation controller, and is situated locally to the controller during a relevant time period. "Water

application devices" are physical devices that distribute water to plants. Typical water application devices are sprinklers, drippers, sprayers, and so forth. The term "remote" with respect to an irrigation controller is taken to mean more than 1 km away from the irrigation controller. The term "third party" is used herein to mean a legal person other than the user. A third party need not be a physical person, and may well be a water district or other government agency.

The term "communication system" is used in a very broad sense herein to mean any system used to communicate information. Contemplated communication systems may be analog or digital, the information may be carried by wires, radio waves, infra-red, light, sound, or any other energy waves, packet switched or not, involve dedicated or non-dedicated lines, may be public or private, or any combination of these. Bi-directional communication systems may or may not be duplex (i.e. carrying signals in both directions at the same time). Contemplated communication systems may use any appropriate hardware. For example, communication between an irrigation controller and a user may employ a key pad for entering data into the irrigation controller, and an LED display for transmitting information from the irrigation controller to the user. Alternatively, sound may be used, such as where a user provides information to the irrigation controller using voice, and the irrigation controller talks to the user using synthesized speech. In yet other embodiments, a user may communicate with an irrigation controller located in the garage of a personal residence, through a personal computer (PC) type keyboard and display screen located in a bedroom of the residence. The link may be hard wired, or it may utilize any other suitable connection, such as the public, packet switched network known as the Internet. Storage devices may again be any suitable information storage, including hard drive, floppy disk, RAM, ROM, and so forth.

The term "personal computer" means any general purpose computing device that is capable of running at least word processing, either from a local source or from an application service provider. Examples are a desk top or laptop computers, very thin clients such as Internet TV, and relatively low capacity equipment such as Palm Pilot™ or other hand-held computers.

Figure 1 shows four communication systems that exchange information in preferred embodiments of the present invention. The first communication system exchanges information between an irrigation controller and a distal computer. The second communication system exchanges information between the irrigation controller and a local user. The third communication system exchanges information between the user and a distal (also referred to as a

"host" computer). The fourth communication system exchanges information between the distal computer and a third party. All of these communication systems are preferably bi-directional. Any suitable communication language can be used to communicate information across any of the communication systems.

Under the definitions set forth herein, aspects of some of these communications systems are already known. For example, it is already known to bi-directionally exchange some types of information between an irrigation controller and a distal computer, and between the irrigation controller and the user. However, both the exchange of irrigation information between the distal computer and the user, and between the distal computer and a third party are thought to be novel for irrigation systems.

Figure 2 is a schematic representation of an interactive irrigation system according to the present invention. The distal computer 10 of Figure 1 is interactively connected to an irrigation controller 20 at a user's location 32 via the first communication system 1. The first communication system 1 is preferably an Internet system, but may alternatively or additionally comprise some other type of communication system such as a telephone system, a radio system, a pager system, two-way pager system, or any other suitable system. An irrigation controller interface 22 is provided for coupling the irrigation controller 20 to the network connection device 13. The network connection device 13 can be a network computer, a personal computer, a cable television box, or any other suitable connection device. Information is preferably transmitted between the irrigation controller interface 22 and the network connection device 13 through a serial communication channel 21.

The first communication system 1 permits the distal computer 10 to transmit control information to the irrigation controller 20. The control information may include irrigation start times 24, irrigation run times 25, and contingency rules that prevent the irrigation controller 20 from operating upon detection of one or more problem conditions. The control information is preferably derived from information inputted, received and/or stored in the distal computer 10. The first communication system 1 also permits the irrigation controller 20 to transmit irrigation information to the distal computer 10. Such information may advantageously include irrigation water flow data 26 and water pressure data 27 (See also Figure 3).

The second communication system 2 allows the user 15 to communicate with the irrigation controller 20. Since both user 15 and controller 20 are local, this could

advantageously be accomplished through a keypad 233 physically located on the irrigation controller 20 (See Figure 3), or in some manner hard wired to the controller 20. Other systems are, however, also contemplated. It is especially contemplated that the user 15 could communicate with the irrigation controller 20 using a desktop computer or laptop computer. Such embodiments may be well appropriate where the controller 20 is in a barn or garage, and the user 15 is operating the controller 20 from within a nearby house or office.

The third communication system 3 is used to transfer information between the user 15 and the distal computer 10, and may also advantageously comprise an Internet system. To this end the user 15 may employ a computer, for example, a personal computer 13 with an Intel Pentium processor and a fast modem. An Internet browser 14 is preferably coupled to the personal computer 13, and is used to provide interactive connection with the distal computer 10. Among other things, the user 15 may input relatively fixed landscape irrigation operating information such as the size, drainage, crop layout, and so forth, and relatively variable landscape irrigation operating information such as irrigation water flow data 26 and water pressure data 27.

The distal computer 10 may advantageously combine the landscape irrigation information with other types of information to derive an irrigation schedule to be downloaded into the irrigation controller 20. Such additional information may include one or more of daily weather data and/or historic ETo values from the user's site or a site with similar meteorological conditions, daily irrigation water flow data 26, and daily irrigation water pressure data 27. It is especially contemplated that the irrigation schedule will be designed to provide efficient irrigation of the landscape with a minimum waste of water. This may involve comparing a computed quantity of water that was applied to the landscape at the user location against an ETo value for that landscape. Differences in these values may be stored, and made available to the user 15 and third parties 11.

The distal computer 10 may also be programmed to detect problems with the irrigation system at the user location 32. This can be accomplished by setting parameters within which the irrigation system, at the user location 32, is determined to be operating effectively. If operation of the irrigation system falls outside of one or more of the parameters, this indicates that a problem with the irrigation system may exist. For example, if the total quantity of water to be applied to the landscape during each scheduled irrigation is determined to be approximately 100 gallons, then upper and lower threshold parameters for total water application could be set at 90

gallons and 110 gallons, respectively. A problem with the irrigation system would be indicated if the quantity of water, applied during any scheduled irrigation, was less than 90 gallons or more than 110 gallons. A lower than normal quantity of applied irrigation water could indicate plugged heads, and a higher than normal quantity of applied irrigation water could indicate broken irrigation lines or sprinkler heads. If problems with the irrigation system at the user location 32 are detected, then the distal computer 10 may warn the user 15 using a visible or audible signal, and/or send control commands to the irrigation controller 20 to prevent the irrigation controller 20 from operating.

Due to cost or for other reasons, presently installed irrigation controllers may not be able to be interactively coupled with the distal computer 10. In such cases it is contemplated that the third communication system may at least partially substitute for the first communication system. For example, it is contemplated that a user 15 may obtain the irrigation schedule from the distal computer 10 through the third communication system 3, and program the irrigation controller 20 directly using the second communication system 2. One scenario is for the user 15 to access the irrigation schedule using a browser program on personal computer 13 and a web site hosted by, or at least controlled by the distal computer 10. Such access can be protected by user identification code and password.

The fourth communication system 4 is used to provide information to a third party. The information thus provided may include operating information such as irrigation start times 24, irrigation run times 25, irrigation water flow data 26, irrigation water pressure data 27, total quantity of water applied to the landscape during a specified time period, and the percent the actual water applied to the landscape represents of the ETo value for the same time period. Where the third party is a water district, this information could be used for billing purposes, monitoring purposes, or for many other reasons. Educational information may travel in the other direction, from third party 11 to distal computer 10, and then on to the user 15, or from third party 11 directly to the user 15.

In Figure 3 an irrigation controller 20 generally includes a microprocessor 220, an on-board memory 210, some manual input devices 230 through 232 (buttons and/or knobs), preferably an irrigation user keypad 233 for entering irrigation identifying information, an input/output (I/O) circuitry 221 connected in a conventional manner, a display screen 250, electrical connectors 260 which are connected to a plurality of irrigation stations 270 and a power supply 280, a rain detection device 291, a flow sensor 26, and a pressure sensor 27. Each

of these components by itself is well known in the electronic industry, with the exception of the programming of the microprocessor in accordance with the functionality set forth herein.

A class of irrigation systems according to the present invention comprises an irrigation controller and a plurality of water application devices that are physically situated at a user's location. The controller at least partially controls the water application devices. A first communication system exchanges information between the irrigation controller and a distal computer, a second communication system exchanges information between the irrigation controller and the user, a third communication system exchanges information between the user and the distal computer; and a fourth communication system that exchanges information between the distal computer and a third party. At least one of these irrigation systems is preferably bi-directional, and in especially preferred embodiments all of these communication systems are bi-directional. At least one of the first, third, and fourth communication systems may advantageously comprise a public, packet switched network, and more preferably comprises an Internet connection that makes use of a web page interface. One or more of the communication systems may involve a dedicated link. One or more of the communication systems may involve a pager, and especially a two-way pager. Microprocessors are advantageously included in at least the irrigation controller and the distal computer to facilitate the communications. The microprocessor at the user location may operate a RAM, ROM, or other data storage device.

A class of inventive methods according to the present invention include physically situating each of an irrigation controller and a water application device at a user's location; utilizing the controller to at least partially control the water application device; coupling the irrigation controller and a distal computer using a first communication system; coupling the irrigation controller and the user using a second communication system; the user entering landscape irrigation operating information into the irrigation controller using the second communication system; and the irrigation controller causing at least a portion of the landscape irrigation operating information to be transmitted to the distal computer using the first communication system.

The controller may advantageously be provided with a microprocessor programmed to receive information from the distal computer and/or local water usage data from local sensors. An irrigation schedule may be determined by the microprocessor in the controller, a microprocessor in the distal computer, or any combination of the two. The irrigation schedule

may advantageously involve computing a desired quantity of water to be applied to a landscape at the user's location for a day, week, month, or other specific period of time. Computations may also advantageously include computing an ETo value, and comparing ETo to the desired quantity of water to be applied to the landscape, and/or the actual water usage. Water usage may in turn be correlated with water pressure date.

Preferred methods may also include a third communication system that couples the user and the distal computer. More preferred methods may include a fourth communication system that couples the distal computer and a third party. The third party may thereby be apprised of many different types of information, including a calculated estimate of water actually applied at a station for a time period, and a relationship between the calculated estimate of water actually applied at a station for a time period and a computed ETo for the station for the time period.

Normal, or at least predetermined, operating parameters may be implemented with warnings being provided to the user or to third parties when operating conditions fall outside the normal parameters. In some instances one of the microprocessors may be used to prevent an operation of the irrigation system when the irrigation system falls outside of the predetermined parameters.

Thus, specific systems and methods of interactive irrigation systems have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims.

CLAIMS

What is claimed is:

1. An irrigation system comprising:
each of an irrigation controller and a water application device physically situated at a user's location, the controller at least partially controlling the water application device;
a distal computer remote from the user location;
a first communication system that exchanges information between the irrigation controller and the distal computer;
a second communication system that exchanges information between the irrigation controller and the user;
a third communication system that exchanges information between the user and the distal computer; and
a fourth communication system that exchanges information between the distal computer and a third party.

2. The irrigation system of claim 1, wherein the exchange of information between each of the irrigation controller and the distal computer, the irrigation controller and the user, the user and the distal computer; and the distal computer and a third party, are bi-directional.

3. The irrigation system of claim 1, further comprising a microprocessor disposed in the irrigation controller, that facilitates the exchange of information between the irrigation controller and the distal computer.

4. The irrigation system of claim 1, further comprising a microprocessor disposed in a second unit separate from the irrigation controller, that facilitates the exchange of information between the irrigation controller and the distal computer.

5. The irrigation system of claim 1, further comprising a storage device that stores data at the user location.

6. The irrigation system of claim 1, wherein at least one of the first, third, and fourth communication systems comprises a public, packet switched network.

7. The irrigation system of claim 1 wherein the first communication system comprises a two-way pager.

8. The irrigation system of claim 1 wherein the first communication system comprises a web page interface.

9. The irrigation system of claim 1, wherein the second communication system comprises a dedicated link between the controller and a personal computer.

10. A method of operating an irrigation system comprising:
physically situating each of an irrigation controller and a water application device at a user's location;
utilizing the controller to at least partially control the water application device;
coupling the irrigation controller and a distal computer using a first communication system;
coupling the irrigation controller and the user using a second communication system;
the user entering landscape irrigation operating information into the irrigation controller using the second communication system; and
the irrigation controller causing at least a portion of the landscape irrigation operating information to be transmitted to the distal computer using the first communication system.

11. The method of claim 10 wherein the step of entering the landscape irrigation operating information comprises the user entering the landscape irrigation operating information into a personal computer, and the personal computer transmitting the information to the irrigation controller via the second communication system.

12. The method of claim 10, further comprising:
providing the controller with a microprocessor programmed to receive additional information from the distal computer via the first communication system; and
the microprocessor determining an irrigation schedule based at least in part on the landscape irrigation operating information from the user, and the additional information from the distal computer.

13. The method of claim 12, further comprising:
providing the controller with local water usage data; and
the microprocessor determining an irrigation schedule based at least in part on the water usage data.

14. The method of claim 13 wherein the step of determining an irrigation schedule further includes the microprocessor computing a desired quantity of water to be applied to a landscape at the user's location for a specific period of time.

15. The method of claim 14 wherein the period of time is at least one day.

16. The method of claim 13 wherein the additional information from the distal computer includes weather data, and further comprising the microprocessor computing an ETo value.

17. The method of claim 16 further comprising the microprocessor comparing the ETo value to the desired quantity of water applied to the landscape.

18. The method of claim 13, wherein the water usage data includes water pressure data.

19. The method of claim 13, further comprising coupling the user and the distal computer using a third communication system;

20. The method of claim 13, further comprising coupling the distal computer and a third party using a fourth communication system.

21. The method of claim 13 further comprising the microprocessor sending a warning to the user via the second communication system when an aspect of the irrigation system falls outside of a predetermined parameter.

22. The method of claim 13 further comprising the microprocessor preventing an operation of the irrigation system when the irrigation system falls outside of the predetermined parameters.

23. The method of claim 13 wherein the information transmitted to the distal computer comprises a calculated estimate of water actually applied at a station for a time period.

24. The method of claim 23 wherein the information transmitted to the distal computer further includes a relationship between the calculated estimate of water actually applied at a station for a time period, and a computed ETo for the station for the time period.

ABSTRACT

An interactive irrigation system exchanges information between an irrigation controller and a distal computer, between the irrigation controller and a user, between the user and the distal computer, and between the distal computer and a third party. The information is preferably exchanged over an Internet communication system. The exchanged information includes the following: irrigation scheduling; quantity of water applied to the landscape at the user location, which is compared to ETo values; warnings to users when potential problems with their irrigation systems are detected; and other irrigation information that is useful to the user or a third party.

List of the Four Communication Systems Used for the Exchange of Information

1	First Communication System	Exchange Information Between the Irrigation Controller and the Distal Computer
2	Second Communication System	Exchange Information Between the Irrigation Controller and the User
3	Third Communication System	Exchange Information Between the User and the Distal Computer
4	Fourth Communication System	Exchange Information Between the Distal Computer and the Third Party

Figure 1

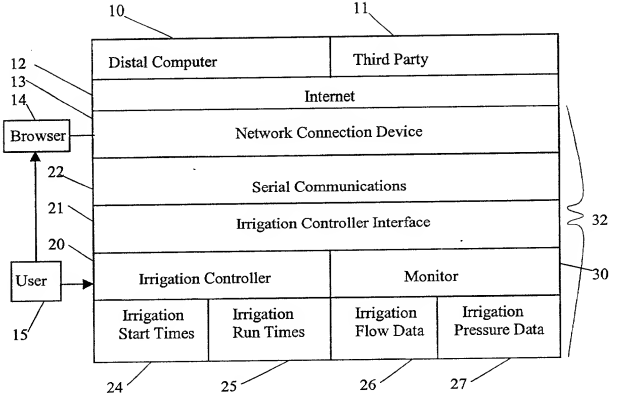
10
11
Distal Computer
Third Party
12
13
14
Internet
Browser
Network Connection Device
22
Serial Communications
21
Irrigation Controller Interface
32
20
User
Irrigation Controller
Monitor
30
15
Irrigation Start Times
Irrigation Run Times
Irrigation Flow Data
Irrigation Pressure Data
24
25
26
27

Figure 2

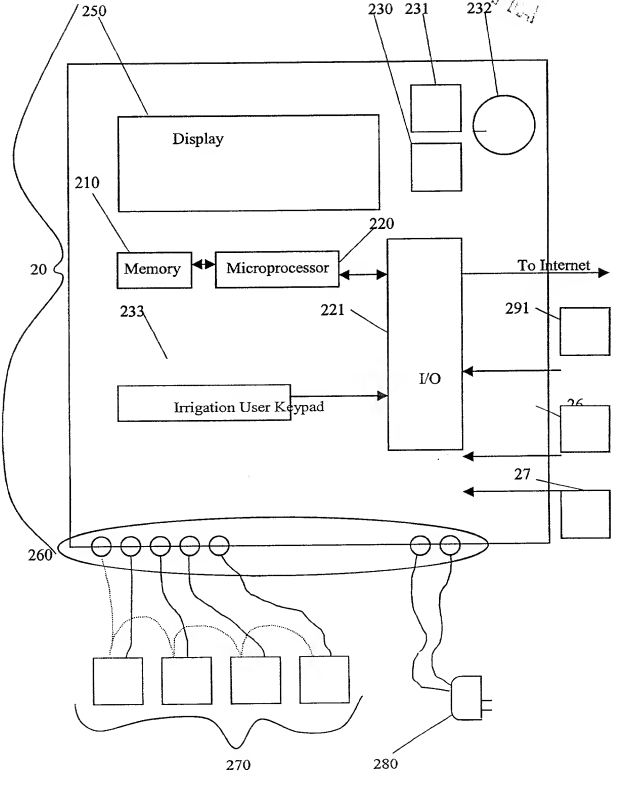

Figure 3

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is for a national stage of PCT application.

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

INTERACTIVE IRRIGATION SYSTEM

SPECIFICATION IDENTIFICATION

The specification was described and claimed in PCT International Application No. PCT/US00/22673 filed on August 17, 2000.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, Section 1.56, and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent.

PRIORITY CLAIM (35 U.S.C. Section 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

Such applications have been filed as follows.

PRIOR PCT APPLICATION(S) FILED WITHIN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. SECTION 119(a)-(d)

INDICATE IF PCT	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 U.S.C. SECTION 119
PCT	PCT/US00/22673	17 August 2000	yes

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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